Original Article

Comparison of T-Loop vs Opus Loop in Canine Retraction Efficacy and Anchorage Loss Control – A Split- Mouth Randomized Clinical Trial

Ayesha Ashraf Khan, Sarah Irfan, Tabassum Ahsan, Maria Moin

Abstract:

Objective: The primary aim was to compare the rate of canine retraction between T loop and Opus loop. The secondary objectives were to compare the angulation of canine, anchorage loss and molar rotation for the two loops used.

Study Design and Setting: A Split- Mouth Randomized Clinical Trial done at Department of Orthodontics, Bahria University of Health Sciences Campus Karachi

Methodology: This study conducted including 14 participants who received both the Opus loop and T-loop in different quadrants. The primary outcome assessed was rate of canine retraction which was measured clinically at every appointment using calibrated calliper. Secondary outcomes included changes in canine angulation, anchorage loss and molar rotation. Canine angulation was measured using periapical radiographs of maxillary canine to 1st molar taken by DIGORA™ Optime at the start of canine retraction and after completion of canine retraction. Anchorage loss and molar rotation was measured by model analysis. For statistical analysis non-parametric test Wilcoxon signed-rank test was used to compare the treatment changes between Opus loop and T-loop.

Result: rate of canine retraction was higher in Opus loop (1.5 mm/month) compared to T-loop (1.45 mm/month) however no statistically significant differences between was found in rate of canine retraction, angulation change, anchorage loss, or molar rotation ($p > 0.05$), indicating comparable clinical performance of both mechanics during space closure.

Conclusion: Both loops showed similar efficacy during canine retraction.

Keywords: anchorage loss, angulation, canine retraction, Opus loop, T-loop

How to cite this Article:
Khan AA, Irfan S, Ahsan T, Moin M. Comparison of T-Loop vs Opus Loop in Canine Retraction Efficacy and Anchorage Loss Control – A Split- Mouth Randomized Clinical Trial. J Bahria Uni Med Dental Coll. 2026;16(3):663-8 DOI: https://doi.org/10.51985 /JBUMDC2026887

INTRODUCTION:

Space closure is considered a biomechanically challenging procedure in orthodontics. The goal of the clinician is to identify methods that enable efficient canine retraction. The basis of biomechanics is important for clinicians to determine anchorage requirements, treatment prognosis, and final outcomes. The choice of biomechanics depends on the requirements of extraction space closure, the patient's age, compliance, and the expertise of the orthodontist.[1,2]

Ayesha Ashraf Khan
Resident, Department of Orthodontics
Bahria University Health Sciences, Campus, Karachi
Email: ayeshaashrafkhan@gmail.com

Sarah Irfan
Assistant Professor, Department of Orthodontics
Bahria University Health Sciences, Campus, Karachi
Email: sarahirfan88@yahoo.com

Tabassum Ahsan
Professor, Department of Orthodontics
Bahria University Health Sciences, Campus, Karachi
Email: ahsan.tab@gmail.com

Maria Moin
Assistant Professor, Department of Orthodontics
Bahria University Health Sciences, Campus, Karachi
Email: mariamoin.bumdc@bahria.edu.pk

Received: 08-01-2026
Accepted: 20-05-2026
1st Revision: 02-02-2026
2nd Revision: 07-05-2026

Extraction spaces can be closed using two methods: (1) frictional/sliding mechanics and (2) non-frictional mechanics. In sliding mechanics, the canine is retracted using NiTi coil springs or elastomeric chains, and friction occurs at the bracket–archwire interface, thereby increasing the overall duration of tooth movement and requiring greater anchorage.[3,4] In contrast, non-sliding mechanics, also known as loop mechanics, involves no friction. It can be achieved using either continuous or segmental mechanics.[5] The continuous method involves fabricating loops in the main archwire, connected to each tooth, which moves around its center of rotation.[5] In the segmented arch technique, the arch is divided into three segments, i.e., two posterior and one anterior, and both posterior and anterior segments are connected through loops.[6] Both segments can be controlled by changing the degree of gable bends and the position of the retraction loops placed between the anterior and posterior segmented arches.[6]

Load–deflection, M: F (moment-to-force) ratio, and vertical force are the main properties of mechanical loops. The M:F ratio is the most significant factor dictating the type of tooth movement. M:F ratios of 7:1 and 10:1 mm are suggested in the literature for controlled tipping and translation, respectively. These M:F ratios can be altered by changing the height of the loop, adding wire horizontally, incorporating a helix, and adjusting the placement of loops and gable bends. Different loop designs such as Gjessing, Ricketts retraction, L-loops, delta loops, T-loop springs (TLSs), and Opus loops have been studied in terms of moment-to-force ratio.[7]

The most important factor affecting the M:F ratio is the height of the closing loop. According to Burstone and Koenig et al[8] a 4 mm loop had an M:F ratio of 1.3, a 6 mm loop had 2.2, and a 10 mm loop had 4. T-loops include a gingival horizontal component that results in a comparatively consistent M:F ratio, a constant optimum force, and a low load–deflection rate throughout the loop's activation range.[5]

Siatkowski invented the Opus loop, an L-shaped helical loop. The helix in the apical region of the L-shape increases the M:F ratio.[7] Studies on Opus loops have demonstrated that they consistently exhibit a 10:1 M:F ratio, enabling bodily tooth movement. However, studies comparing the T-loop and Opus loop in terms of canine retraction rate, angulation of the canine, and anchorage loss are limited. Therefore, our study aims to compare the Opus loop and T-loop in terms of tooth movement and associated side effects.

The primary objective of this split-mouth randomized controlled trial (RCT) was to compare the canine retraction rate of the T-loop with the Opus loop. The secondary objectives were to evaluate canine angulation and changes in the position of the first molar in terms of anchorage loss and molar rotation for the two loops used. Our study was conducted based on the null hypothesis that there would be no significant difference in the rate of canine retraction, angulation of the canine, molar rotation, and anchorage loss between the T-loop and the Opus loop.

METHODOLOGY:

Our split-mouth RCT was conducted with a 1:1 allocation ratio between the right and left quadrants. ERC approval was obtained from the Institutional Review Board (IRB#018/23), and no changes were made after the trial commencement. The trial was registered in (No: NCT06945575). Recruitment begin in February 2025 and data collection was completed in July 2025.

All patients reporting to the department of Orthodontics were assessed for eligibility after record collection and finalization of their Orthodontic treatment plans. Participants included in the study were 1) aged between 14 to 40 years, 2) planned extractions of maxillary first premolars, 3) Class 1, 1/4th, ½, and 3/4th unit Class II molar relation 4) presence of all teeth up to second molar 5) good oral hygiene. Exclusion criteria were 1) full cusp Class II 2) developmental, medical or genetic problems 3) patients taking bisphosphonates 4) spacing in dentition 5) grossly carious upper molars which cannot be restored 6) patients with active periodontal disease, and 7) severe crowding. Patients who agreed to participate in the trial signed an informed consent. Consecutive sampling technique was used to enroll patients.

A total of 14 participants were included, who received both Opus loop and T-loop in different quadrants. Group 1: Opus loops 14(n) Group 2: T-loop 14(n). Randomization was performed using a simple lottery method, where allocation (right/left quadrant) was determined using sealed opaque slips to ensure allocation concealment. Half of the participants received Opus loop on right and T-loop on left side, while reverse was true for the other half.

After banding of first and second molars, bonding was done using brackets with MBT prescription (slot 0.022"×0.028", Orthocare UK) along with extractions of first premolars. 0.014" Niti was used for the initial levelling and alignment, and wires were progressed to 0.017"×0.025" Niti in the same sequence for all participants. Second molar, first molar, and second premolar were held by 0.017"×0.025" stainless steel (S.S) and colligated using steel ligature wire. Opus and T-loop were fabricated with 0.017"×0.025" S.S wires. The loops were placed midway within the extraction space. (Figure 1) A single experienced clinician fabricated and inserted the loops. Pre-activation bends of 30° and anti-rotational bends were given in the T-loops. Opus loop was inserted without any pre-activation bends. Each loop was activated 2 mm at each appointment, and it was continued till completion of canine retraction.

Rate of canine retraction was the primary outcome and was calculated by "the amount of canine retraction (in millimetres) divided by the time interval". Amount of canine retraction was assessed by measuring the distance from canine cusp tip to the mesiobuccal (MB) cusp tip of the 1st molar with a calibrated calliper at the time of placement of loops and at every month by a single calibrated clinician. The duration was measured as time interval and each time interval was 4 weeks. Even though the canine cusp tip and first molar mesiobuccal cusp are capable of orthodontic movement, this approach was chosen as it represents net change experienced by the canine–molar segment, which forms as a clinically relevant unit to retraction. An examiner, calibrated each 4-week period, made the measurement to avoid variability. Anchorage loss was also independently measured via cast analysis so that we could evaluate whether linear tooth movement was a result of canine retraction or mesial movement of the molars.

Secondary outcomes were change in angulation of canine, anchorage loss, and molar rotation. Periapical radiographs of maxillary canine to 1st molar were taken by DIGORA™ Optime at the start of canine retraction and after completion of canine retraction. X-ray film holders were used while taking periapical radiographs for standardization of x-ray. A single calibrated examiner analysed angulation of canine by measuring an angle formed between vertical line drawn from buccal cusp tip of canine till root apex in reference with long axis of 2nd premolar. (Figure 2)

Anchorage loss and rotation of molar was measured by performing model analysis. Impression of patient was taken with alginate material before and after canine retraction. Figure 3. shows that the left and right third rugae were taken as reference points to measure anchorage loss. A horizontal line was constructed from mesiobuccal cusp tip of right and left first molar till mid palatal raphe. Distance between the horizontal line and the third rugae was measured on both sides at start and at end of the canine retraction. The difference between pre and post value represented anchorage loss.

Figure 4. shows that rotation of molar was measured as a difference between angle formed between line passing through distobuccal cusp tip and mesiopalatal cusp tip of 1st molar to mid palatal raphe was measured before and after canine retraction. To assess intra-observer reliability, all measurements were repeated after two weeks. Sample size was calculated with Open Epi software, Version 3.0, using the findings of Davis et al.[5] who reported the mean of tipping of the canine using Marcotte spring 6.645°± 2.744 and while using T-loop 1.229° ± 5.124. Keeping á = 0.05, a power of 80% and a confidence interval of 95%, the software calculated a sample size of 14 participants for each group with total 28 sides allocated. Due to the nature of the intervention in this split-mouth study, blinding of the operator and patients was not possible. However, all radiographic and model-based outcome assessments were carried out by a blinded independent examiner who was unaware of group allocation, minimizing potential measurement bias.

Data were analyzed using SPSS (IBM Corp, Version 23.0, NY, USA). Descriptive analysis was applied for the qualitative data. The intraclass correlation coefficient (ICC) was used to check intra-observer reliability. The Kolmogorov-Smirnov test was performed to test normality of the data and indicated that data were non-normal. Therefore, the treatment changes between Opus and T-loop were compared with a non-parametric Wilcoxon signed-rank test. A p-value = 0.05 was considered statistically significant.

RESULT:

Figure 5 shows the Consolidated Standards of Reporting Trials flowchart demonstrating 50 participants were analyzed for eligibility out of which 28 participants were included in study. Each group was allocated with 14 participants and there was no lost to follow-up. No participants were excluded from analysis. ICC value showed that measurements for angulation of canine (ICC: 0.91), anchorage loss (ICC:0.88) and molar rotation (ICC:0.96) were reliable.

Table 1 shows total of 14 participants, out of which 11 were females with a mean age of 17.73 ± 2.27 years and 3 were males with a mean age of 18.00 ± 2.36 years were included.

Table 2 shows canine retraction rate, angulation of canine, rotation of molar, and anchorage loss. Wilcoxon signed-rank test showed no statistically significant difference between the Opus loop and T-loop in any of the evaluated parameters. The median rate of canine retraction was comparable between the Opus loop (1.5 mm/month) and T-loop (1.45 mm/month) (p = 0.834). Similarly, no significant difference was observed in angulation change (p = 0.271), anchorage loss (p = 0.857), or molar rotation (p = 0.953).

DISCUSSION:

Several closing loops have been designed to provide a high M:F ratio and low force deflection rate enabling optimal retraction, bodily translation, minimal anchorage loss, and reduced rotation.[5,9] M:F ratio can be altered by changing the length, diameter, or material of the wire, addition of a helix,

Figure 1: T-loop and Opus loop placed for canine retraction

Figure 2: Canine angulation measured with reference to 2nd premolar

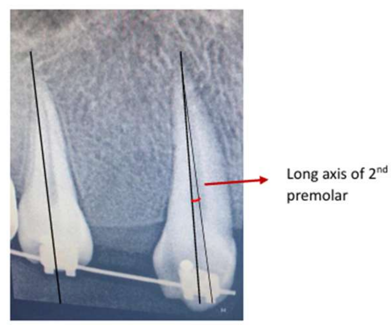

Figure 3: A horizontal line was drawn from mesiobuccal cusp tip of right 1st molar to left 1st molar. Anchorage loss was measured from mesial point of third rugae to the horizontal line. "A" measures anchorage loss from right molar. "B" measures anchorage loss from left mola**r**

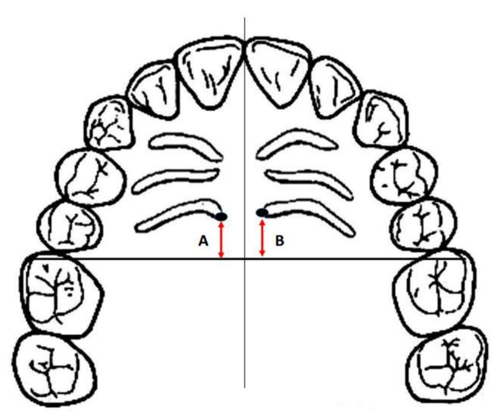

Figure 4: A diagonal line was drawn from distobuccal cusp tip to mesiopalatal cusp tip of 1st molar till mid palatal raphe. An angle formed between midpalatal raphe and diagonal line was measured as molar rotation. “C” measures right molar rotation. “D” measures left molar rotation.

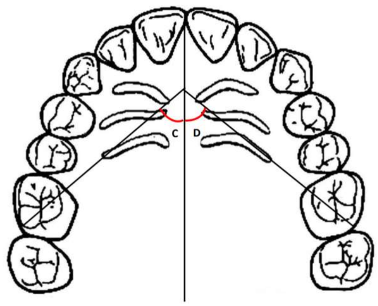

Figure 5: CONSORT diagram showing flow of patients through the trial

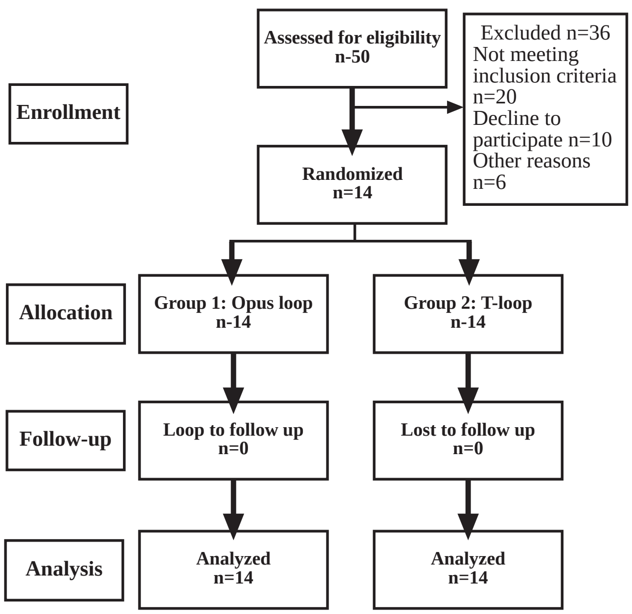

Table 1: Demographic Data

Gender	Female n=11	Male n=3
Mean age ± STD (years)	17.73±2.27	18.00±2.36

N=14, STD: Standard Deviation

Table 2: Comparison of Opus loop and T-loop

Variable	Opus Loop (Median [IQR])	T-loop (Median [IQR])	p-value*
Rate of retraction	1.5[0.44]	1.45[0.62]	0.834
Angulation change	1.0 [10.0]	0.5 [6.5]	0.271
Anchorage loss	-0.5 [1.25]	-1.0 [1.63]	0.857
Molar rotation	0.0 [2.0]	0.0 [5.0]	0.953

Wilcoxon signed-rank test for comparison of Opus loop and T-loop, p<0.05*

and pre-activation bends.[7,10] M:F ratio of 10:1 is required for bodily translation, whereas 7:1 is required for controlled tipping. [12] Different loops such as vertical closing, bull loop, snail loop, T-loop, L-loop, Opus loops have been designed to achieve the highest M:F ratio. According to Techalertpaisarn P et al.[7] M:F ratio is increased by increasing the height of the loop, however due to soft tissue limitation no loop can reach optimum height. The horizontal component of T-loop increases M:F ratio but then levels off. To achieve high M:F ratio Siatkowsk iet al.[13,14] designed an Opus loop by changing loop design by incorporating a helix in a L shaped loop. In their study they reported that Opus loop provides constant force delivery without pre-activation bends. Finite element model (FEM) showed that loops with helix had three times greater M:F ratio as compared to loops without helix. [9] Safavi MR et al.[15] who compared vertical helical closing loops, L-loops, and T-loops with pre-activation bends against Opus loops without pre-activation bends reported that pre-activation bends increased the M:F ratio at 0.1mm of activation.

In our study, it was found that Opus loop had faster rate of retraction than the T-loop however, there was no significant difference between them. Our result was in accordance with Obaidi H et al.[16] who compared rate of retraction, tipping and rotation of 8 different loops. He found that rate of space closure was insignificantly higher in opus loop(0.734mm) as compared to T-loop(0.711mm).

Findings based on this study, degree of tipping was greater in the Opus loop than in the T-loop, but the difference was not statistically significant. Our findings were similar to Obaidi et al.[16] however he found statistically significant difference in canine angulation between Opus loop and T-loop he stated that this difference was due to the change in the angle between the vertical portion (i.e., pre-activation bends), which alters the force distribution. The reason for increased tipping of the canine with Opus loop in our study may be due to absence of pre-activation bends in the Opus loop .Safavi MR et al.[15] stated in his study that T-loop and Opus loop without pre-activation bends have similar mechanical behavior whereas incorporating pre-activation bends in both loops increased M:F ratio and the Opus loop had slightly increased M:F ratio (7.6mm) as compared to the T-loop (7.26mm). Similarly, Davis S et al.[5] compared Marcotte loop with T-loop and he found that T-loop had lower degree of tipping than Marcotte. In his study only anti-extrusion bends were placed in Marcotte loop whereas pre-activation bends were only placed in T-loop, these pre-activation bends provided greater control of tooth movement with the T-loop. In contrast to our study Barot M et al.[17] in his study compared segmented T-loop, mushroom loop and Opus loop and concluded that segmented T-loop showed greatest distal movement of canine and controlled tipping compared to mushroom loop and Opus loop.

One of the major considerations during canine retraction is preservation of the anchorage. Anchorage can be increased by increasing M:F ratio in posterior segment. This is usually done by placing pre-activation bend in beta arm i.e. in posterior segment, that creates a moment which tips crown distally or by asymmetric loop positioning which generates moment on the segment closer to loop. The findings revealed that less anchorage loss was seen in Opus loop compared to T-loop however the difference was not statistically significant. Less anchorage loss in Opus loop can be due to addition of helix, or an increased length of wire which increase the M:F ratio. However, result of our study contradicted with Barot M et al.[17] who suggested that T-loop is the most efficient loop for canine retraction as it has minimum intrusive effect and anchorage loss, maximum canine retraction in a single activation compared to mushroom and Opus loop. According to Masaes et al.[18] who compared T-loop with Ricketts maxillary canine retractor in term of anchorage loss control found T-loop had better anchorage control than Ricketts maxillary canine retractor. The rigid wire design of T-loop stabilizes the posterior segment which redistribute stress level to large surface and decreases force in the reactive unit.

Molar rotation was found to be less in Opus loop than T-loop but showed no significant difference. Masaes et al.[18] in their study also found no significant difference in molar rotation when he compared T-loop with Ricketts maxillary canine retractor.

In literature greater emphasis has been shown to biomechanics of space closure and biological response to forces. For predictable tooth movement adequate force system, loop geometry and positioning of loops plays a critical loop. Finding of these study shows that when all biomechanics principles are followed, different loop will yield similar clinical outcome. [19,20,21]

Limitations of the study: Periapical radiographs used in study provide two-dimensional assessment and may be affected by magnification, distortion, and superimposition of anatomical structures. Measurement of canine retraction using the mesiobuccal cusp tip of the first molar as a reference may introduce bias due to possible molar movement (anchorage loss). Rotation of the canines was not evaluated; however, rotation may affect the linear retraction measurement. Our radiographic focus was on angulation, and thus this factor is a methodological limitation of the study. For future research, more consistent and complete evaluation of canine movement with CBCT or other 3D methods is recommended that includes larger number of subjects, with a narrower age span, as well as balanced sex distribution and more consistent malocclusion characteristics to enhance external validity and increase the overall robustness of findings

CONCLUSION:

There is no significant difference between Opus loop and T-loop in terms of canine retraction rate, canine angulation, anchorage loss and molar rotation. Owing to similar efficiency of both loops either can be used in clinical setting according to clinicians' choice.

Conflicts of Interest: Nil

Source of Funding: Nil

Acknowledgement: Nil

Authors Contribution:
Ayesha Ashraf Khan: Concept and design, data collection, analysis, interpretation, manuscript writing
Sarah Irfan: Conceptualization, reviewing and editing supervision
Tabassum Ahsan: supervision, final approval of manuscript
Maria Moin: supervision

REFERENCES:

1. Ribeiro GL, Jacob HB. Understanding the basis of space closure in Orthodontics for a more efficient orthodontic treatment. Dent Press J Orthod. 2016;21:115–25.
2. Barsoum HA, ElSayed HS, El Sharaby FA, Palomo JM, Mostafa YA. Comprehensive comparison of canine retraction using NiTi closed coil springs vs elastomeric chains: a split-mouth randomized controlled trial. Angle Orthod. 2021;91(4):441–8. DOI: https://doi.org/10.2319/110620-916.1
3. Trpevska V, Tanatarec I, Srbinoska D, Mijoska A. Straight wire and segmented technique in canine retraction: case reports. Arch Public Health. 2022;14:1. DOI: https://doi.org/10.3889/aph.2022.6024
4. Nandan H, Kumar CS, Jha P. Comparison of maxillary canine retraction using split-mouth design with dual force cuspid retractor and T-loop segmental arch: a split-mouth randomized clinical trial. Cureus. 2023;15(2).
5. Davis S, Sundareswaran S, James J. Comparative evaluation of the efficiency of canine retraction using modified Marcotte and T-loop retraction springs – a split-mouth, randomized clinical trial. J Orthod Sci. 2019;8:1–7.
6. Ozaki H, Tominaga JY, Hamanaka R, Sumi M, Chiang PC, Tanaka M, et al. Biomechanical aspects of segmented arch mechanics combined with power arm for controlled anterior tooth movement: a three-dimensional finite element study. J Dent Biomech. 2015;6:1–9. DOI: https://doi.org/10.1177/1758736014566337
7. Techalertpaisarn P, Versus A. Mechanical properties of Opus closing loops, L-loops, and T-loops investigated with finite element analysis. Am J Orthod Dentofacial Orthop. 2013;143(5):675–8. DOI: https://doi.org/10.1016/ j.ajodo.2013.01.011
8. Burstone CJ, Koenig HA. Optimizing anterior and canine retraction. Am J Orthod. 1976;70(1):1–9. DOI: https://doi.org/10.1016/0002-9416(76)90257-8
9. Kumari S, Niranjane P. Evaluation and comparison of moment-to-force ratio of a new "PRP loop" with that of Opus loop and L loop: a finite element method study. J Clin Diagn Res. 2023;17(5):ZC11–ZC15. DOI: https://doi.org/10.7860/JCDR/2023/63343.17944

10. Geramy A, Mahmoudi R, Geranmayeh AR, Borujeni ES, Farhadifard H, Darvishpour H. A comparison of mechanical characteristics of four common orthodontic loops in different ranges of activation and angular bends: the concordance between experiment and finite element analysis. Int Orthod. 2018;16(1):42–59. DOI: https://doi.org/10.1016/j. ortho.2018.01.011
11. do Amaral Ferreira M, Rodrigues FRM, Luersen MA, Borges PC. Closing loops: geometry and mechanical properties – a review. Orthod J Nepal. 2022;12(1):64–74.
12. Nanda R. Biomechanics in clinical orthodontics. Philadelphia: Saunders; 1997.
13. Siatkowski RE. Continuous arch wire closing loop design, optimization, and verification. Part I. Am J Orthod Dentofacial Orthop. 1997a;112:393–402. doi:10.1016/S0889-5406(97)70047-7 DOI: https://doi.org/10.1016/S0889-5406(97)70047-7
14. Siatkowski RE. Continuous arch wire closing loop design, optimization, and verification. Part II. Am J Orthod Dentofacial Orthop. 1997b;112:487–95. doi:10.1016/S0889-5406(97)70075-1 DOI: https://doi.org/10.1016/S0889-5406(97)70075-1
15. Safavi MR, Geramy A, Khezri AK. M/F ratios of four different closing loops: 3D analysis using the finite element method (FEM). Aust Orthod J. 2006;22(2):121–6.
16. Obaidi H, Sabah O. Evaluation of tipping, rotation and rate of space closure of canine retraction by frictionless orthodontic techniques (An in vitro study). Al-Rafidain Dent J. 2006;6(3):30–7.
17. Barot M, Shah A, Hirani S, Thakore K, Desai S, Pancholi D. Comparative evaluation of different loops for individual canine and en-masse retraction: a finite element method (FEM) study. Int J Health Sci. 2022;6(S1):3037–50. DOI: https://doi.org/10.53730/ijhs.v6nS1.5302
18. Masaes MM, Burhan AS, Youssef M, Nawaya FR. T-loop spring vs Ricketts maxillary canine retractor in canine retraction efficacy and anchorage loss control: a cone-beam computed tomography study. AJO-DO Clin Comp. 2022;2(1):26–40. DOI: https://doi.org/10.1016/j.xaor.2021.12.001
19. Rodrigues EU, Maruo H, Guariza Filho O, Tanaka O, Camargo ES. Mechanical evaluation of space closure loops in orthodontics. Braz Oral Res. 2011;25:63–8. doi:10.1590/S1806-83242011005000003
20. Sanjay N, Rajesh RN, Scindia R, Ajith SD. Space closure with loop mechanics for treatment of bimaxillary protrusion: a case report. J Int Oral Health. 2015;7(5):65–8.
21. Harada R, Yokoi Y, Kamoi A, Miyawaki R, Yoshida T, Kawamura J, et al. Biomechanical analysis of extraction space closure with various loop springs incorporated into an archwire. Appl Sci (Basel). 2023;13(4):2616. doi:10.3390/app13042616